The Association of Frequency and Level of Physical Activity on the Progression of Osteoarthritis of the Knee in Females

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ABSTRACT

Throughout the world, osteoarthritis (OA) is one of the most common arthritic diseases and causes of disability among the elderly today (Fries, Singh, Morfeld, Hubert, Lane, and Brown, 1994). Recent studies have been conducted on osteoarthritis of the knee in order to determine if any factors present in a person's life could alter the course of the disease. Radiography is a common method for imaging the course of this disease over time. Gender has also been captured in many studies on osteoarthritis, but rarely has it been compared in relation to OA and physical activity.

The purpose of this study is to determine the association between the frequency and level of physical activity and the progression of osteoarthritis of the knee in females as demonstrated by radiographic knee joint space narrowing evaluation. One additional factor considered in this study is the compartment of the knee affected (lateral versus medial). The radiographic description of osteoarthritis of each knee is given by an OARSI scale grade (0-3) as reported by the Osteoarthritis Initiative (OAI). A descriptive analysis was performed and the results of the study demonstrated an association between the frequency and level of physical activity in females and the progression of osteoarthritis of the knee by radiographic joint space narrowing. The two extreme levels of physical activity including no activity and strenuous activity demonstrated an association, while the two intermediate levels did not indicate a relationship.

CHAPTER 1

PROBLEM STATEMENT

The World Health Organization approximates that several hundred million people currently suffer from bone and joint diseases, with significant increases predicted due to a doubling in the number of people over the age of 50 by 2020 (Arthritis Foundation, 2005). Throughout the world, osteoarthritis (OA) is one of the most common arthritic diseases and causes of disability among the elderly today (Fries, Singh, Morfeld, Hubert, Lane, and Brown, 1994). OA is predicted to increase considerably as a larger proportion of the population surpasses 60 years of age (Hayes, Jamadar, Welch, Jannausch, Lachance, Capul, and Sowers, 2005). This "wear and tear" disease on the knee joints poses a serious problem to quality of life since it can prevent people from doing everyday activities in their lives that involve strenuous joint movements or even just being able to exercise without pain and stiffness in their knees (McAlindon, Wilson, Aliabadi, Weissman, and Felson, 1999). According to the Arthritis Foundation, nearly 21 million Americans today suffer from OA. These staggering numbers should lead health care professionals to identify factors that could slow the progression of OA of the knee.

Osteoarthritis mostly affects joints such as the hip, knees, hands, back, and neck, which are commonly used in a wide range of activities (Arthritis Foundation, 2005). The knee joints are one of the most common to develop OA since they are a large part of leisure activities that involve various levels of sport and recreation, which can be hard on the knees. Not being able to use the knees for long periods of time can make it harder for people to exercise or do simple tasks throughout their lives.

The amount of physical activity has been found to be beneficial to a person with OA because it decreases obesity; however it has also been found to cause injury due to strenuous activity (Manninen, Riihimaki, Heliovaara, and Suomalainen, 2001). The loss of joint function due to the progression of OA is a major cause of work disability, financial burden, and reduced quality of life (Arthritis Foundation, 2005). Since regular exercise is widely encouraged as a way to improve and keep good health, it is imperative that people understand its possible effects on OA (Cheng, Macera, Davis, Ainsworth, Troped, and Blair, 2000).

Without the utilization of radiographic imaging, the hardening of bone, bony outgrowths (osteophytes), and cysts underneath the surface of bone would not be visible to the naked eye and the discovery of knee OA would be difficult to diagnose (Concoff, 2005). In order to properly diagnose these patients, physicians will order some form of radiographic imaging for a patient with knee osteoarthritis. This could be multiple diagnostic radiographs of the knee or even an MRI to rule out any further causes of pain and to ascertain the amount of joint damage that has occurred (Arthritis Foundation, 2005). Although there is some controversy over which modality is best for imaging osteoarthritis of the knee, multiple sources have discussed that MRI is best for diagnosing osteoarthritis of the knee while diagnostic radiographs are better for looking at the progression of OA of the knee. The amount of tissue contrast, high spatial resolution, and cross sectional image display of MRI present an impressive ability to show bone, cartilage, and soft tissue irregularities that is needed for whole-organ appraisal of the knee (Hayes, Jamadar, Welch, Jannausch, Lachance, Capul, and Sowers, 2005).

Osteoarthritis is the fourth most common predictor of health problems world wide in women (Pascual, 2003). It is responsible for more than 7 million physician visits per year, and is second only to cardiovascular disease as the leading cause of chronic disability in adults (Arthritis Foundation, 2005). Gender has also been captured in many studies on OA, but rarely has it been compared in relation to OA and physical activity. Additionally, gender may influence the suspected inverse relationship between osteoarthritis and bone density (Hart, Doyle, and Spector, 1999). Some other popular factors thought to be associated with knee OA include obesity and age (Hart, Doyle, and Spector, 1999).

The purpose of this study was to assess if an association exists between the frequency and level of physical activity and the progression of knee osteoarthritis as indicated by radiographic examination of the knee joint space in a female population.

REVIEW OF LITERATURE

A study conducted by Lanyon, O'Reilly, Jones, and Doherty (1998) analyzed the progression of knee OA by assessing joint space width in average subjects. The subjects included 294 women and 158 men. Each subject that had knee pain was matched with a person who didn't have knee pain as his or her control for comparison. The subjects all had radiographs taken of both their knees, and the images were measured for space narrowing and the presence of osteophytes. The results showed for both male and females there was no large decline in joint space in any part of the knee with increasing age. Also no strong relationship was determined between joint space and weight, height or BMI. There was a correlation found between the subjects having pain and the presence of osteophytes in the knee. A limitation for this study is that they collected information on pain from each person and not specifically where the pain was in each knee. There is also a chance for bias since the subjects had to describe their pain. The results of this study also show that specific compartments of the knee should be assessed when looking at radiographs for osteophyte formation (Lanyon, O'Reilly, Jones, and Doherty, 1998). This study was helpful in determining possible radiographic findings in the knee joint. My research, on the other hand, will focus more on risk factors that can possibly be the cause of those findings. Additional research is needed with this study in order to determine why joint space is lost and osteophytes formed.

Osteoarthritis of the knee has been found to be more prevalent in the elderly. A Framingham Study (McAlindon, Wilson, Aliabadi, Weissman, and Felson, 1999) investigated the risk of radiographic and symptomatic knee osteoarthritis in the elderly in

relation to the level of physical activity. The subjects participated in a physical activity questionnaire and obtained radiographs of their normal weight-bearing knees. A few years later follow-up knee radiographs and a history of knee symptoms were obtained. The radiographs were scored on a Kellgren and Lawrence scale to determine the presence of osteoarthritis. The questionnaire asked specific questions regarding pain in each knee and the length of time the pain was present. Participants were asked about their level of physical activity and grouped into categories of light, moderate, or heavy activity. The subjects' BMI was also obtained. The analysis of the data was based on the number of hours spent in each type of physical activity. The results showed that the amount of hours per day doing a heavy physical activity was related with the risk of incident radiographic knee OA. Many factors contributed to this association such as BMI, knee injury, smoking, age, and weight loss. More risk was found for people with a higher BMI and at a more elderly age. The light and moderate physical activities didn't seem to show a significant increase in risk. Some significant limitations to this study include the lack of accuracy in describing the activities of the subjects, the inability to find which actual activities result in increased risk, and the misclassification of reported activities with their duration by the participants (McAlindon et al., 1999). This study would be working in relation to my research, but again it doesn't involve gender as a factor. Additional research is needed to specify which activities have a greater impact on increased risk of osteoarthritis of the knee (OAK). Also more accurate information on the duration of the activities needs to be collected in further research.

Cheng, Macera, Davis, Ainsworth, Troped, and Blair (2000) performed a research study to evaluate the effect physical activity could have on osteoarthritis. This study was

somewhat different than the previous works cited in that it focused on physician-diagnosed osteoarthritis instead of the development of OA. The subjects involved in this study included people aged 20 years or older. The subjects all underwent clinical examinations and completed a questionnaire at each visit regarding health and life style habits. In order to be part of the study, the participants had to have reported physician – diagnosed OA in the knee or hip. Physical activity was based on participants walking and jogging since these activities were the most common activities in the population. Other variables included in the data collection were gender, age, BMI, history of smoking, alcohol use, and caffeine consumption. The data was analyzed separately according to gender. According to the results, OA was more prevalent among women than men age 50 years and older while the incidence of OA was similar between them under the age of 50. In men, higher levels of activity (running 20 miles or more per week) were related to OA but only after managing their body mass index (BMI), smoking, and use of alcohol or caffeine. In women, there was no relation between OA and regular physical activity, smoking, or alcohol use. However in younger males, higher levels of physical activity increased the risk of developing OA. One of the major limitations of this study is the use of self-reported information, which could include recall bias. Overall, this study demonstrated that higher levels of physical activity could affect incidence of OA in younger men and not have a significant affect among women and older men (Cheng et al., 2000). This study looks more at previously diagnosed osteoarthritis. This study does provide valuable information as to osteoarthritis in men but no relationship was found for women. This also can lead to the want of additional research involving women's development of OAK.

A case-control study (Manninen, Riihimaki, Heliovaara, and Suomalainen, 2001) was conducted to determine a relationship between physical exercise and the risk of severe knee osteoarthritis that could possibly lead to arthroplasty (knee replacement). This study involved both male and female subjects between the ages of 55 and 75 years old. All the cases had previously undergone a knee arthroplasty due to primary osteoarthritis. The subjects were all interviewed regarding job history, physical activities, knee injuries, weight, height, and smoking habits. The interviews also went into detail on the type and amount of exercise they perform in a week. The results demonstrated that stressful physical work in women tended to increase the risk of knee arthroplasty. Also physical exercise was found to decrease the probability of undergoing a knee arthroplasty. In both male and females, the more hours spent exercising by the age of 49 years the lower the risk of this type of surgery. However, certain sports were seen as a greater risk for developing knee osteoarthritis in women. Sports such as walking, swimming, cross-country, and skiing all seemed to increase the risk of OA in females but there were no specific sports that increased risk of OA in males. With regard to knee OA, there was no correlation observed in men or women between physical work, knee injury, and physical exercise. Some sources for error in the study were that certain joint problems could inhibit the ability to do physical exercise and the possibility of recall bias with regard to physical activity (Manninen et al., 2001). This study seems to disagree with most other studies because it states that physical exercise was found to decrease the probability of undergoing a knee arthroplasty, which leads people to believe that exercise is decreasing their symptoms and risk of OA progression. Most of the other studies demonstrated results that showed exercise as a factor that increased OA progression,

which could possibly lead to knee surgery. Further research needs to be done relating physical activity to OAK in order to support this study or dispel it. More research would discover the reason for this disagreement between studies and possibly provide a more accurate result.

Previous studies have hypothesized that running could be a detriment to the knee joint. Disability in the elderly is usually connected to increased occurrence of osteoarthritis. A longitudinal study (Fries, Singh, Morfeld, Hubert, Lane, and Brown, 1994) based on running and increasing disability with age was conducted to determine any possible effect between the two. There were 451 subjects classified as "runners" and 330 controls based as "nonrunners". All the participants received a questionnaire that included many factors relating to their life style and health. They were asked about their running habits and the duration in the activity. The results showed that osteoarthritic changes increased in many joints including the knees over time. They found that there was no difference between the runners and nonrunners. Therefore, the study concluded that the runners had less disability due to an improvement in health that came with conditioning the body and not due to a change in osteoarthritis. A major limitation of this study is that persons who chose to run may be different in their characteristics, which can lead to a decrease in disability (Fries et al., 1994). This study provides data on how an increased amount of running affects the risk of disability over time, but it does not specifically focus on osteoarthritis. It also only looks at running as a form of physical activity and does not include low or more moderate activities. This study also does not include the types of surfaces (asphalt roads, rubberized track, or treadmill) that the participants are running on. The differences in running surfaces could result in different

stresses or impact forces on the knees. More research should be done to look at running as a possible risk factor for OA, which could be the reason for disability. Also research should be done on different types of activity and not just sport related activity.

There is some evidence that suggests quadriceps strength decreases with age, but the relationship between quadriceps strength and knee osteoarthritis is still controversial. A case-control design study conducted by O'Reilly, Jones, Muir, and Doherty (1998) investigated this relationship and its effect on pain and disability in the community. This study involved 300 men and women with pain and 300 control participants without pain. The subjects had undergone a survey regarding their knee pain and questions about their disability. Each subject also had their anxiety and depression assessed along with their quadriceps strength. Radiographs were taken of the knee joint and scored accordingly for osteophytes, narrowing, and sclerosis in each knee. The data showed that the cases with knee pain had considerably lower quadriceps strength than the controls without any pain. This study believes that the level of disability or inactivity can increase muscle wasting and can help in decreasing quadriceps strength in the elderly populations. Some sources for error in this study included selection bias since response rates were somewhat low and the analysis of problems in only one knee instead of both (O'Reilly et al., 1998). The effect of quadriceps strength on knee OA provides valuable information into the progression of OA. This study will help with further research and might possibly provide an explanation for not only the effect that physical activity has on the progression of OAK, but also how the medical community might delay the onset of OA by encouraging quadriceps strengthening exercises. More research needs to be focused on what specific activities can increase muscle strength and possibly reduce progression of OAK.

A study performed by Rogind, Bibow-Nielson, Jensen, Moller, Frimodt-Mcller, and Bliddal (1998) looked at the effect of physical training on patients with knee OA. The study design was a randomized control trial with the patient follow-up visits at three months and one year. The sample consisted of 28 individuals that had bilateral pain due to diagnosed knee OA. Each patient had radiographs taken of their knees and were scored using the Kellgren Lawrence scale on their progression of OA. The subjects were randomly divided into a case or control group. The case patients were asked to come in for training sessions twice a week and to train at home also. The case group underwent muscle strengthening to improve support for the knee along with many other exercises including flexibility. After each follow up visit the patients were asked a series of questions regarding their pain and disability in the knees. They were also tested on postural sway (balance), muscle strength, and basic functional tests (time walking up stairs). The results showed that general physical training could be favorable to patients with knee OA. The physical training did improve muscle strength, increased walking speed, and decreased pain. This study showed that it is possible for patients with serious knee OA to undergo a physical training program. Some adverse effects of this program included an increase in knee joint effusions after the start of the program and continued throughout that could lead to more disease activity. A limitation to this study included the small sample size and the lack of generalizability of the study. The purpose for this study was to show that exercise programs for people with OA could result in improved muscle strength, flexibility, coordination, and reduced pain without causing progression of the disease (Rogind, Bibow-Nielson, Jensen, Moller, Frimodt-Mcller, and Bliddal, 1998). This study is geared more toward ways of decreasing the progression of OAK. It suggests

that activities such as physical training are beneficial for patients. If more research were to be conducted, then a larger sample would be used to obtain more generalizable results. My research involves physical activities that patients usually do during the course of their life instead of specific exercises aimed at increasing joint movement and flexibility.

OBJECTIVE

- What is the association of the level of physical activity (none, light, moderate, strenuous) after the development of OA of the knee and the progression of osteoarthritis of the knee in females as demonstrated by applying the OARSI (Osteoarthritis Research Society International) scale to assess radiographic knee joint space narrowing?
- What is the association of the frequency of physical activity (never, seldom, sometimes, often) after the development of OA of the knee and the progression of osteoarthritis of the knee in females as demonstrated by applying the OARSI (Osteoarthritis Research Society International) scale to assess radiographic knee joint space narrowing?

CHAPTER 2

PROCEDURES

Population and Sample

A sample of females with a diagnosis of OA affecting the knee was analyzed. The sample size was estimated to include 486 females that fit the study criteria. The inclusion criteria were women ages 45-79 years, all ethnic groups, and have symptomatic knee pain and OA. The exclusion criteria were participants with rheumatoid arthritis, males, bilateral total knee joint replacement or plans to have it, and a positive pregnancy test. All data has previously been collected by OAI and can be accessed on their online database. The OAI database captured extensive data on patients, but this study focused on the participants' physical activity levels and the OARSI scale grade of baseline knee radiographs and 12-month follow-up knee radiographs. The Ohio State University IRB approval has already been acquired before the collection of the data since the University is a participant in the OAI.

Design

This is a descriptive study explaining the level and frequency of physical activity in the progression of osteoarthritis as indicated by radiographic examination of the knee joint space in a female population. It is a retrospective, secondary data analysis of an existing database created by the Osteoarthritis Initiative (OAI). The independent variables of the study are frequency of physical activity, which is coded as never (0 days/week), seldom (1-2 days/week), sometimes (3-4 days/week), and often (5-7 days/week) and the level of physical activity, which is coded as light (light sport/recreation leisure activities), moderate (moderate sport/recreation), and

strenuous (strenuous sport/recreation). The dependent variable is the progression of OA as demonstrated using the OARSI scale to assess radiographic knee joint space narrowing in the medial and lateral compartments, which classifies three grades of osteoarthritis of the knee. Grade 0 = normal knee joint; Grade 1 = mildly narrowed joint with some articular cartilage present; Grade 2 = moderate narrowing with alteration of bone contour; and Grade 3 = severe narrowing of joint or compete loss of joint space.

Instrumentation and Data Analysis

Data was collected on all female OAI participants from the existing OAI databank meeting the criteria described in this study. However, individual data was not available due to confidentiality reasons, so only aggregate data was obtained. The frequency of physical activity, level of physical activity, and OARSI scale grade of knee radiographs of the lateral and medial compartments were used for analysis. A descriptive analysis was performed evaluating baseline and 12-month aggregate data regarding the frequency of osteoarthritis disease progression. The right and left knee group data were combined since there is assumed equal amount of OA progression and physical activity in both knees. The data was then organized into separate medial tibiofemoral and lateral tibiofemoral compartments of the radiographed knees. The proportion of subjects in each OARSI grade for baseline and 12-month data was compared based on level of physical activity and amount of physical activity per week. Percentage changes in the baseline and 12-month OARSI grades were calculated and graphed using Microsoft Excel. Information at the individual

participant level was not available; therefore analysis using Spearman Rho as described in the original proposal is not possible.

CHAPTER 3

RESULTS

Light Activity

The results regarding light physical activity demonstrated a few changes in the OARSI grades throughout the 12-month period. In analyzing the lateral tibiofemoral compartment of the knee, the participants who did not exercise showed a definite progression toward a higher OARSI grade on the 12-month follow-up evaluation. After 12-months, 100% of the females who reported never participating in light physical activity were graded as an OARSI level 3. The participants with an OARSI grade 1 or grade 2 that never exercised over the 12-months had a slight joint space narrowing resulting in an increased OARSI grade. The participants with an OARSI grade 0 had no changes in their grade throughout the time period regardless of the frequency of activity.

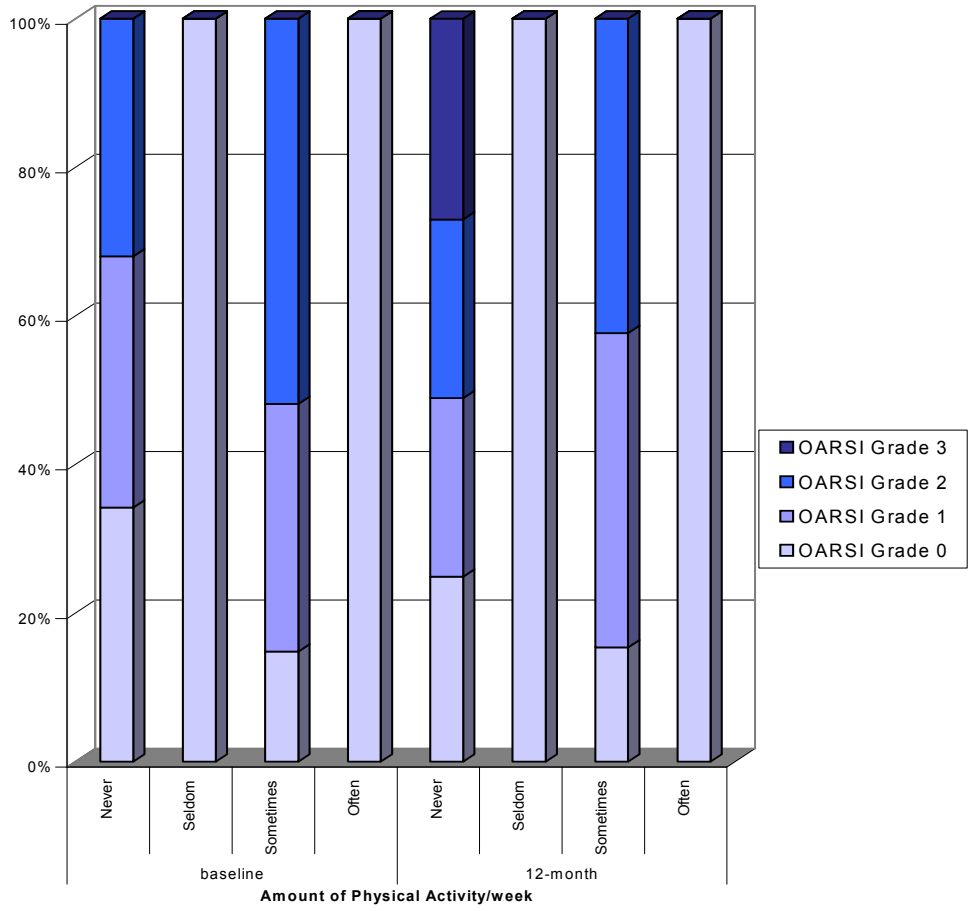
At baseline, no females performing light activity were identified with an OARSI of grade 3.The participants that exercised seldom (1-2 days/wk) and often (5-7 days/wk) had no progression of joint space narrowing, thus OARSI grades remained unchanged. The participants who performed light physical activity 3-4 days/wk (sometimes) had minimal changes in their grades. However, the OARSI grade actually decreased at the 12-month follow-up. At baseline 14% had an OARSI grade of 2 and at 12-months only 11% had an OARSI grade of 2. Refer to Table 1 and Figure 1.

Table 1.

Light Activity- Lateral Compartment of the Knee

	baseline				12-month			
Grade	Never	Seldom	Sometimes	Often	Never	Seldom	Sometimes	Often
0	92%	2%	4%	3%	92%	2%	4%	3%
1	91%	0%	9%	0%	89%	0%	11%	0%
2	86%	0%	14%	0%	89%	0%	11%	0%
3	0%	0%	0%	0%	100%	0%	0%	0%

Figure 1. Frequency of Light Physical Activity per week Related to the Percentage of Participants in each OARSI Grade in the Lateral Tibiofemoral Compartment of the Knee



Upon radiographic evaluation of the medial tibiofemoral compartment of the knee, those participants who reported no physical activity and had a baseline OARSI grade 3 had no change in the OARSI grade at 12-month follow-up. Females who reported no physical activity in OARSI grades 0-2 demonstrated a slight change. At baseline, 93% of this population was evaluated as OARSI grade 2 and only 87% were evaluated as OARSI grade 2 on the 12-month follow-up examination. Since individual data was not available, it is difficult to ascertain if the progression of joint narrowing increased or decreased or if the individual participants increased physical activity to account for the 6% change. At 12-month follow-up, 94% of the females reporting no physical activity were evaluated as OARSI grade 1 compared to 93% at baseline evaluation; and 89% of the females reporting no physical activity with an OARSI grade 0 at baseline changed to 90% with an OARSI grade 0 at 12-month follow-up.

No changes were noted in females who reported performing light physical activity 1-2 days per week (seldom) and were identified as OARSI grades 0, 1, or 3. However, a 2% increase is noted in females who reported "seldom" light physical activity and demonstrated an OARSI grade 2 at 12-month follow-up. This could indicate that 2% of grade 2 participants increased physical activity over the 12 month period accounting for the decrease in the "never" category accompanied by the increase in the "seldom" category. Light exercise is often encouraged to help these females maintain mobility and improve range of motion.

The participants reported performing light physical activity 3-4 days per week (sometimes) appear to have an increase in progression over the 12-month period. A 1%

decrease was noted in those participants who were graded as an OARSI 0 accompanied by a 1% increase in OARSI grade 1 and a 4% increase in OARSI grade 2. This could also result from increased activity during the 12 month period to explain the decrease in percentages in grades 1 and 2 in the "never" category. It is important to note, however, that none of the participants who reported performing light physical activity 3-4 days per week were graded a level 3 at baseline evaluation or at the 12-month follow-up evaluation.

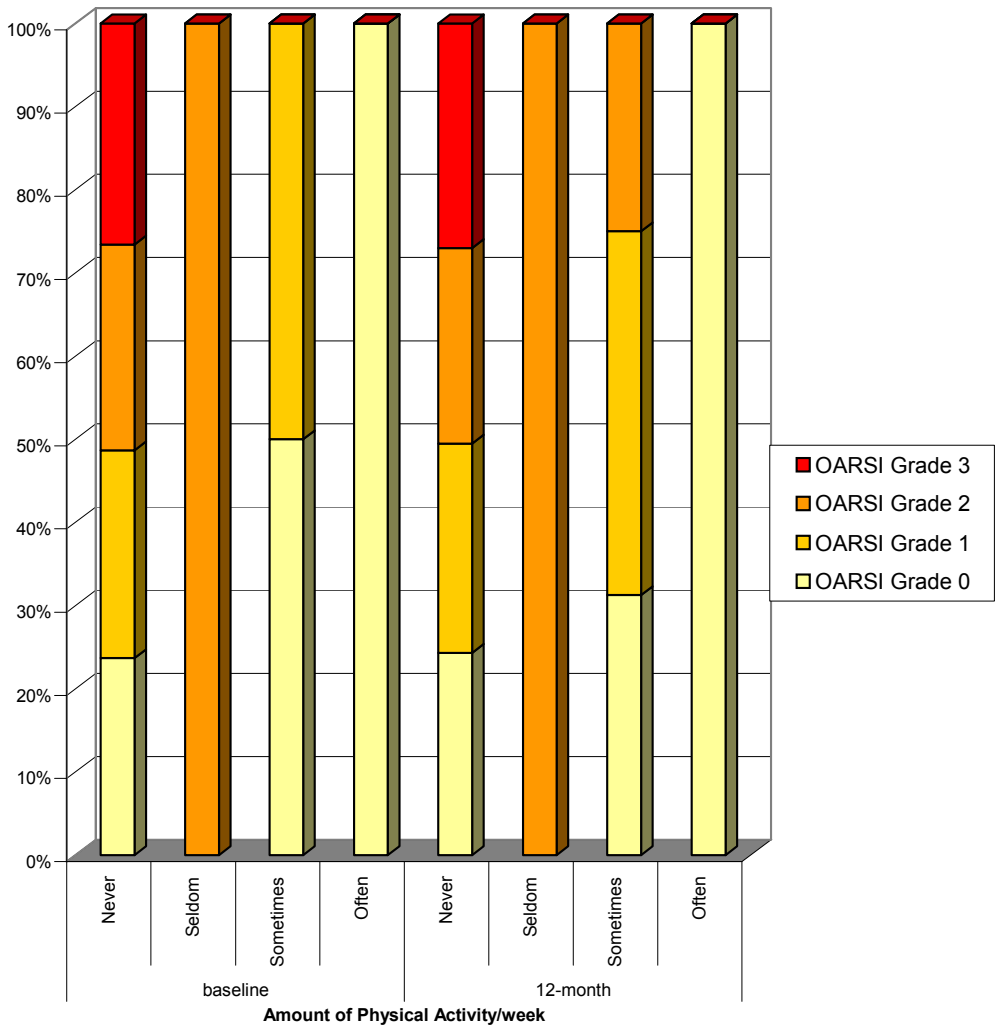
Participants who often (5-7 days per week) engaged in light physical activity demonstrated no changes between baseline evaluation and at the 12-month follow-up evaluation. All participants remained at grade 0 indicating no disease was present. Refer to Table 2 and Figure 2.

Table 2.

Light Activity- Medial Compartment of the Knee

	baseline				12-month			
Grade	Never	Seldom	Sometimes	Often	Never	Seldom	Sometimes	Often
0	89%	0%	6%	5%	90%	0%	5%	5%
1	94%	0%	6%	0%	93%	0%	7%	0%
2	93%	7%	0%	0%	87%	9%	4%	0%
3	100%	0%	0%	0%	100%	0%	0%	0%

Figure 2. Frequency of Light Physical Activity per week Related to the Percentage of Participants in each OARSI Grade in the Medial Tibiofemoral Compartment of Knee



Moderate Activity

In the lateral tibiofemoral compartment of the knee, the participants that underwent moderate activity had no changes in their grade if they reported participating in moderate physical activity 3-7 days per week (sometimes or often). All the participants that sometimes or often engaged in moderate physical activity remained a grade 0 indicating no disease was present radiographically.

The percentage of participants that reported seldom participation in moderate physical activity and were graded as OARSI grade 1 at baseline was 9%, however at the 12-month follow-up evaluation this percentage increased to 11%. Since this percentage increased and the percentage of participants with an OARSI grade 1 who did not engage in exercise decreased between baseline and the 12-month follow-up evaluation, the results would suggest an increase in the number of females who engaged in moderate physical activity over the interim 12-month period. The percentage of females with a baseline OARSI grade of 0 reporting seldom participation in moderate physical activity remained a grade 0 on the 12-month follow-up examination.

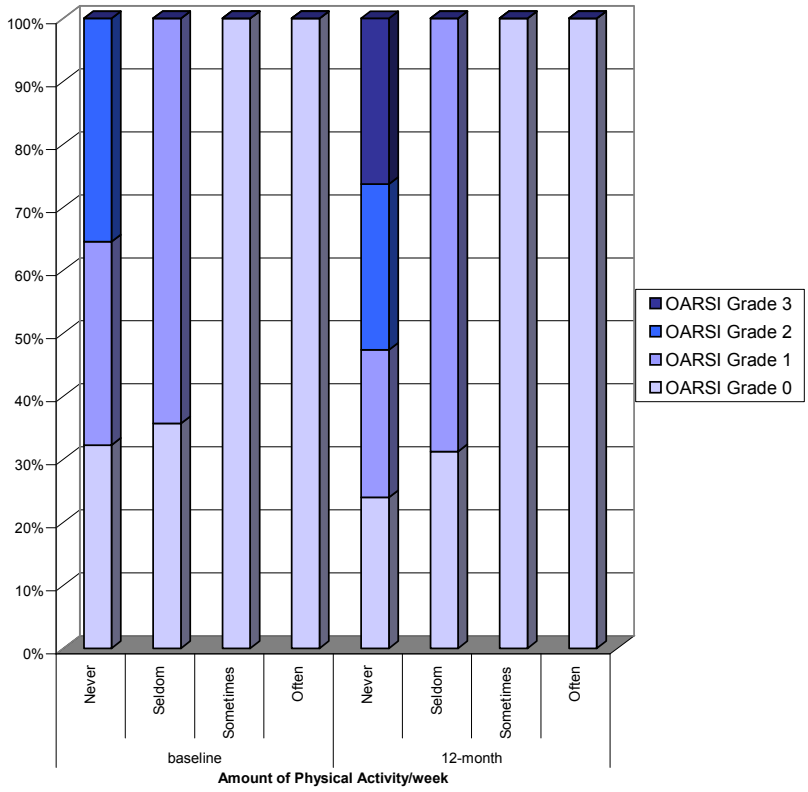
There was a definite progression to a higher grade for participants who did not engage in any moderate physical activity. This category of participants demonstrates a 2% shift increase in OARSI grade 1 between baseline and at the 12-month follow-up evaluation in combination with an increase in the percentage of participants exhibiting an OARSI grade 3 on the 12-month follow-up examination. Refer to Table 3 and Figure 3.

Table 3.

Moderate Activity- Lateral Compartment of the Knee

	baseline				12-month			
Grade	Never	Seldom	Sometimes	Often	Never	Seldom	Sometimes	Often
0	91%	5%	2%	3%	91%	5%	2%	3%
1	91%	9%	0%	0%	89%	11%	0%	0%
2	100%	0%	0%	0%	100%	0%	0%	0%
3	0%	0%	0%	0%	100%	0%	0%	0%

Figure 3. Frequency of Moderate Physical Activity per week Related to the Percentage of Participants in each OARSI Grade in the Lateral Tibiofemoral Compartment of the Knee



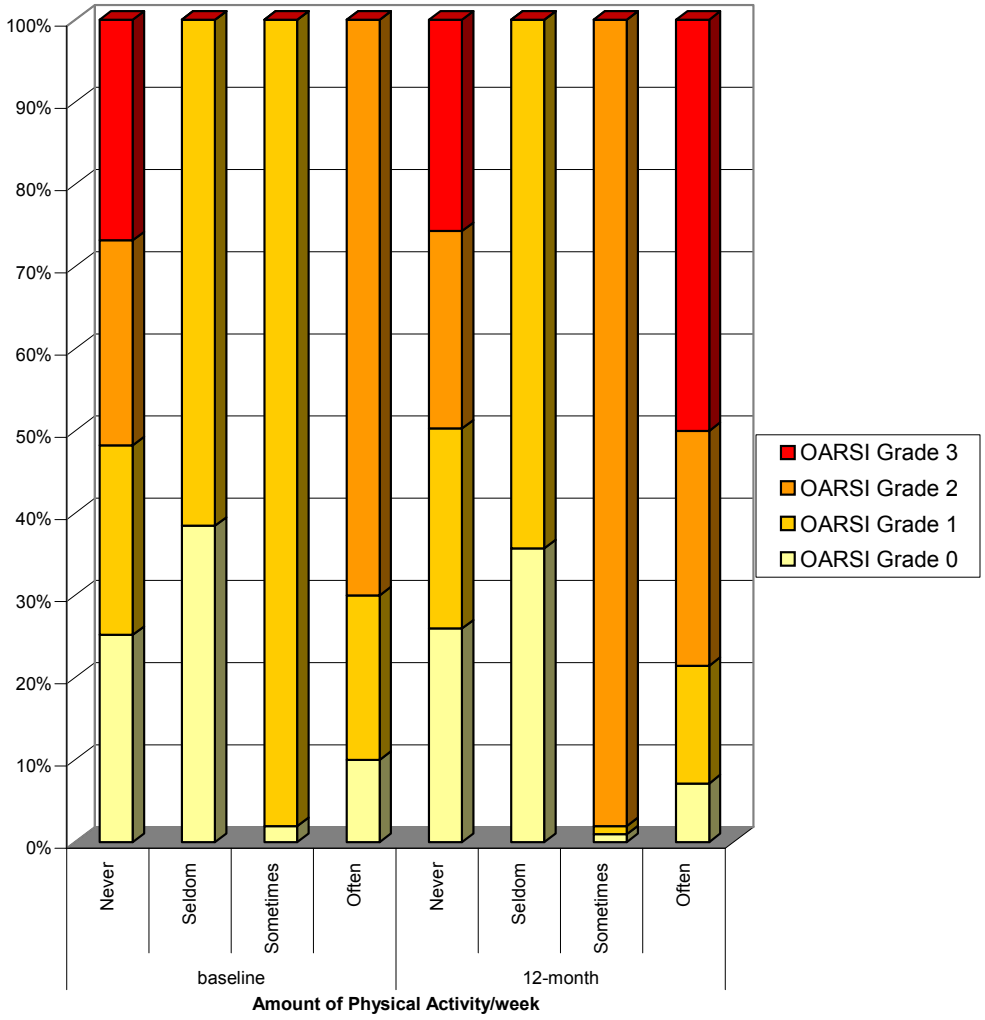
In the medial tibiofemoral compartment of the knee, 100% of the participants with an OARSI grade 3 at baseline did not participate in moderate physical activity. At 12-month follow-up this decreased to 93% accompanied by a 7% increase in those females who reported engaging in moderate physical activity 5-7 days/week. No change was identified in participants who did not participate in moderate physical activity and were graded with an OARSI grade 0 (no disease). A decrease of 6% was noted between baseline measurements and the 12-month follow-up in participants with an OARSI grade of 2 who did not participate in moderate physical activity. This was accompanied by an increase in the same population reporting engaging in moderate physical activity 3-7 times per week suggesting that some individuals changed their level of physical activity over the 12-month interim period.

The participants that often participated in moderate physical activity had the greatest change in OA progression. At baseline, there were no participants or 0% with a grade 3 and 7% with a grade 2 which progressed to 7% and 4% respectively after 12-months. This suggests that increasing participation in moderate physical activity beyond 4 days per week may actually have a detrimental effect on the progression of OA of the knee in these subjects. Refer to Table 4 and Figure 4.

Table 4.
Moderate Activity- Medial Compartment of the Knee

	baseline				12-month			
Grade	Never	Seldom	Sometimes	Often	Never	Seldom	Sometimes	Often
0	94%	5%	0%	1%	94%	5%	0%	1%
1	86%	8%	4%	2%	88%	9%	0%	2%
2	93%	0%	0%	7%	87%	0%	9%	4%
3	100%	0%	0%	0%	93%	0%	0%	7%

Figure 4. Frequency of Moderate Physical Activity per week Related to the Percentage of Participants in each OARSI Grade in the Medial Tibiofemoral Compartment of the Knee



Strenuous Activity

In the lateral tibiofemoral compartment of the knee, a small progression to a higher OARSI grade was noted in participants that never engaged in strenuous physical activity. The participants with an OARSI grade 0 remained at 69%, while the females with an OARSI grade 1 changed from 82% to 89% over the 12-months. Participants that never engaged in strenuous physical activity with an OARSI grade 2 progressed from 29% at baseline evaluation to 44% at the 12-month follow-up examination suggesting that participating in some level of physical activity may slow the progression of OA.

There was also progression from OARSI grade 1 or grade 2 in the participants reporting seldom engagement in strenuous physical activity resulting in a 4% shift. Because individual data is not available, it is difficult to ascertain if this finding suggests that an increase in the frequency of exercise will decrease the progression of OA or whether the opposite is true, i.e. even limited strenuous activity increases the progression of OA.

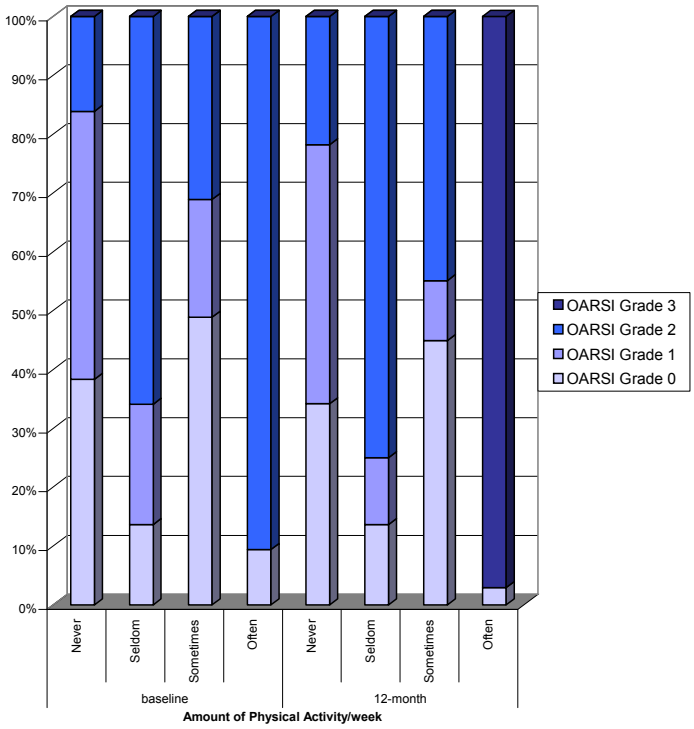
The participants that reported participating in strenuous physical activity 3-4 times/week and were graded an OARSI level 1 at baseline demonstrated an increase in disease progression at the 12-month follow-up examination. The percentage participants with an OARSI grade 1 decreased by 4% at the 12-month follow-up evaluation. This was accompanied by an 8% increase in OARSI grade 2 at the 12-month follow-up evaluation. This could suggest that some individuals increased their physical activity over the 12-month period or that participating in strenuous activities 3-4 times per week actually increases the progression of OA in this population. The assumption that strenuous physical activity increases the progression of OA is also supported by a transition of

individuals from an OARSI grade 2 at baseline to an OARSI grade 3 at 12-month follow-up in participants that reported engaging in strenuous physical activity 5-7 times/week. Refer to Table 5 and Figure 5.

Table 5.
Strenuous Activity- Lateral Compartment of the Knee

	baseline				12-month			
Grade	Never	Seldom	Sometimes	Often	Never	Seldom	Sometimes	Often
0	69%	6%	22%	3%	69%	6%	22%	3%
1	82%	9%	9%	0%	89%	5%	5%	0%
2	29%	29%	14%	29%	44%	33%	22%	0%
3	0%	0%	0%	0%	0%	0%	0%	100%

Figure 5. Frequency of Strenuous Physical Activity per week Related to the Percentage of Participants in each OARSI Grade in the Lateral Tibiofemoral Compartment of the Knee



In the medial tibiofemoral compartment of the knee, there was only a slight change in OARSI grades in participants that never engaged in strenuous exercise, those participants that sometimes engaged in strenuous activity, and those that reported engaging in strenuous physical activity 5-7 times per week.

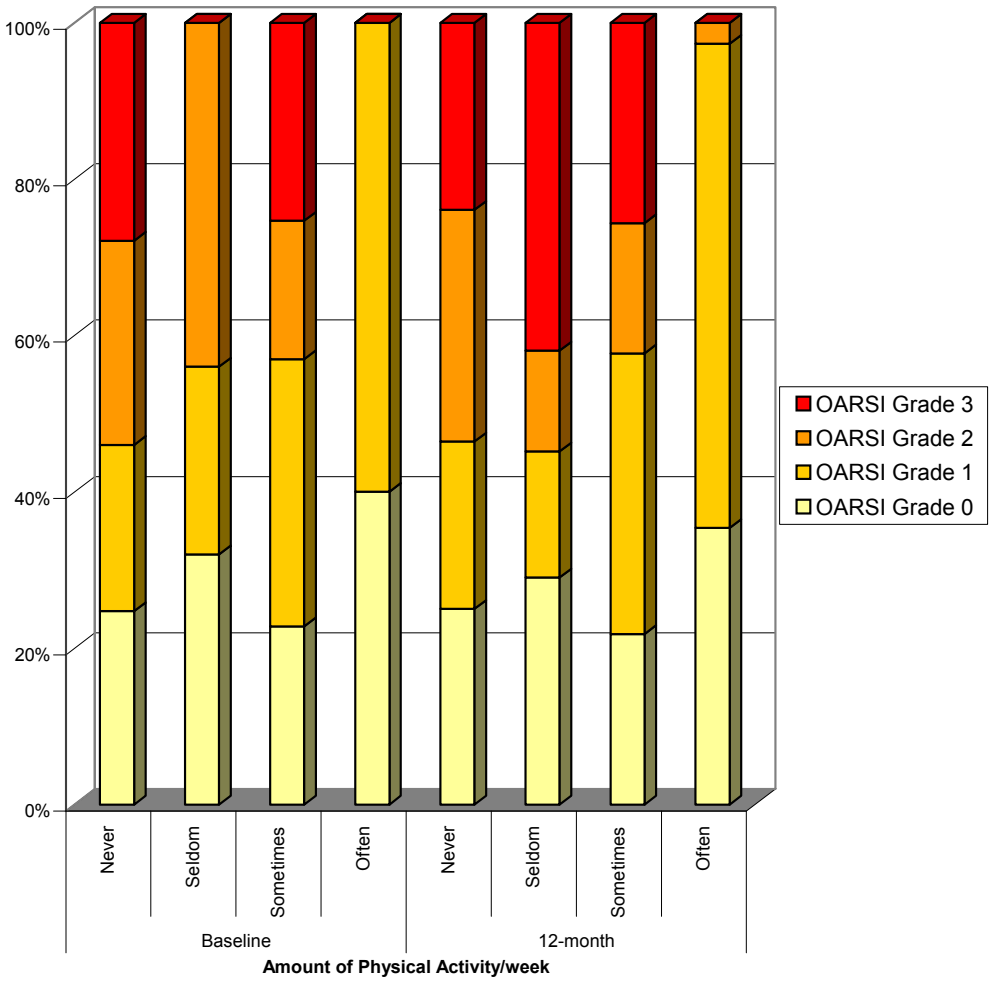
The participants that reported participating in strenuous physical activity 1-2 times per week had very minimal changes in OARSI grades 0 and 1, however progression of OA is noted in participants who were graded 2 at baseline evaluation. A 7% decrease is noted in OARSI grade 2 accompanied by a 13% increase in OARSI grade 3. This again suggests that participating in strenuous physical activity may actually increase the progression of OA of the knee in this particular population. Refer to Table 6 and Figure 6.

Table 6.

Strenuous Activity- Medial Compartment of the Knee

	Baseline				12-month			
Grade	Never	Seldom	Sometimes	Often	Never	Seldom	Sometimes	Often
0	71%	8%	18%	4%	70%	9%	17%	4%
1	61%	6%	27%	6%	60%	5%	28%	7%
2	75%	11%	14%	0%	83%	4%	13%	0%
3	80%	0%	20%	0%	67%	13%	20%	0%

Figure 6. Frequency of Strenuous Physical Activity per week Related to the Percentage of Participants in each OARSI Grade in the Medial Tibiofemoral Compartment of the Knee



DISCUSSION

This is a descriptive study of data from an existing Osteoarthritis Initiative (OAI) database to find if an association exists between the frequency and level of physical activity and the progression of osteoarthritis of the knee in females. Females were chosen as the sample for this study due to the growing population of females affected by osteoarthritis. A few previous studies considered gender when determining a relationship between physical activity and osteoarthritis. One study suggests that above the age of 50, women have a higher prevalence of OA than men (Cheng et al., 2000). Another study found that certain exercises and sports increase the risk of OA in females (Manninen et al., 2001). Continuing in the same path as the aforementioned studies, the researcher chose to make women's association with OA the focus in the current study. According to the results of the current study, many female participants experienced progression of OA the knee over the 12-month period possibly due to physical activity or the lack of. The progression of osteoarthritis of the knee in this study was determined by radiographic knee evaluation. Each previously obtained radiograph was given a grade from the OARSI scale that described its level of OA progression. The level of physical activity used was broken down into the frequency of physical activity per week in order to determine whether the amount of activity could have an affect on the progression of OA. The levels of physical activity were defined as light, moderate, or strenuous sport/recreation leisure activities. Another factor that was considered in this study included the different compartments of the knee affected by osteoarthritis. Data from the right and left knee was combined, and then the data was categorized by lateral and medial tibiofemoral compartments of the knee.

Most of the previous studies performed on the correlation between osteoarthritis of the knee and the level of physical activity found that there was some degree of relationship. A Framingham study found that light and moderate physical activities resulted in no increase in risk of osteoarthritis of the knees, while the heavier physical activities did show an increase in risk possibly due to additional factors (McAlindon et al., 1999). In another study, no relationship was found between OA of the knee and physical activity (Manninen et al., 2001). The results of this study seem to agree slightly more with the Framingham study where at the higher levels of physical activity, the more there is an affect on the progression of OA of the knee. As demonstrated in the results, a greater number of participants with OARSI grades changed to a higher grade in the highest level of physical activity. Most of the changes in OARSI grades occurred in the strenuous physical activity level with only a few exceptions in the light and moderate levels. There were very few changes in the participants' grades in the light and moderate physical activity levels that were not due to participants possibly changing their frequency of physical activity during the 12-month period. This shows that the level of physical activity may have an association with the progression of OA of the knee under specific considerations.

Overall, strenuous physical activity seems to have a larger affect on the progression of OA in the knee than light or moderate physical activity. The results of this analysis suggest progression of OA regardless of the frequency of physical activity; however, since individual data was not available, a determination of a significant association between light and moderate physical activity and the progression of osteoarthritis could not be made. Participants appeared to increase the frequency of

physical activity over the 12-month evaluation period; therefore, the changes in percentages demonstrated in the OARSI grades is difficult to explain. The association between the level of physical activity and progression of OA indicates that the higher the level of physical activity, the greater the changes to a higher OARSI grade or the more the disease progresses. The participants who never participated in physical activity also demonstrated a strong association with the progression of OA of the knee. These results tend to suggest that the two extremes of physical activity have a relationship with the progression of OA of the knee.

Another factor that was included in this study was the frequency of each level of physical activity. This was organized into the number of days per week that level of physical activity was completed. The Framingham study also analyzed data based on the number of hours each participant spent in each type of activity (McAlindon et al., 1999). The results demonstrated that the females who did seldom physical activity (1-2 days/week) had no consistent relationship. Some of the participants progressed to a higher grade, while others had no change in their grade over the 12-months. In the participants that sometimes (3-4 days/week) did physical activity, the results were similar to the seldom physical activity category. There was no relationship apparent due to varying results. However, both the seldom and sometimes physical activity frequencies were the only ones that had results demonstrating a reversed progression of OA of the knee. Data was not consistent to evaluate if this amount of physical activity could slow the progression of OA of the knee. The participants that did often (5-7 days/week) engage in physical activity also had varied results, thus no clear relationship was demonstrated. However, at lower levels of physical activity (light), there was no effect on the

progression of OA and at higher levels (strenuous) there was an effect on the progression of OA. This indicates that a high frequency (5-7day/week) of light activity does not seem to affect the progression of OA of the knee and would be beneficial for health purposes. At a high frequency of strenuous activity, there seems to be some effect on the progression of OA, therefore, a lower frequency of physical activity might be more beneficial for other health purposes. Due to the lack of consistent results, no clear relationship can be drawn between the frequency of physical activity and the progression of OA of the knee.

The last factor that was considered when analyzing the data for this study was the possible differences between the medial and lateral tibiofemoral compartments of the knee. There were no previous studies found that included the different compartments of the knee as a variable in terms of the progression of OA of the knee in females. One study stated that specific compartments of the knee should be assessed in diagnosing OA, but the study did not include specific information in the results (Lanyon, O'Reilly, Jones, and Doherty, 1998). According to the results of the OAI data analysis, the lateral tibiofemoral compartment of the knee was affected by physical activity and had a slightly greater progression of osteoarthritis compared to the medial compartment in the only strenuous level of physical activity. The participants changed from a lower to a higher OARSI grade more often at this level indicating the progression of OA. At the light and moderate physical activity levels, the medial compartment seemed to demonstrate a greater progression of OA of the knee. The medial tibiofemoral compartment of the knee demonstrated greater OA of the knee progression overall at various physical activity levels regardless of the frequency. At the high physical activity level, the lateral

compartment showed a relationship to the progression of OA of the knee, while at the moderate and light activity levels the medial compartment showed more of a relationship with the progression of OAK.

Variations in the progression of OA and the compartments of the knee could be due to the anatomy of the knee. According to a study by Mundermann, Dyrby, and Andriacchi (2005), the medial tibiofemoral compartment of the knee is more commonly affected by changes due to osteoarthritis than the lateral tibofemoral compartment. This is usually due to meniscal damage since the medial meniscus is more susceptible to trauma than the lateral. If the medial meniscus was damaged and decreased in size, then the medial joint space would collapse resulting in the bones trying to compensate for this change by extending out segments of bone. Another reason the medial tibiofemoral compartment is affected more often by OA is because the weight load conveyed during walking is greater on the medial side than the lateral side (Mundermann, Dyrby, and Andriacchi, 2005). The results are probably due to the medial tibiofemoral compartment being the compartment that is affected first by OAK so it is demonstrated at the lower levels of activity. At the more strenuous level of activity, the lateral tibiofemoral compartment becomes affected due to a greater load from the body impacting on both sides of the knee.

A major limitation for this study includes the inability to obtain individual data on the female participants from the online OAI database. Instead, aggregate data was obtained limiting this to a descriptive study instead of allowing statistical analysis using a Spearman Rho. Also since individual data was not available, it was difficult to ascertain if the findings suggest whether the frequency and level of physical activity will decrease

or increase the progression of osteoarthritis of the knee due to individuals changing their amount of physical activity over the 12-month period.

In conclusion, this descriptive analysis suggests an association between the level of physical activity and the progression of osteoarthritis of the knee in females demonstrated by radiographic joint space narrowing. The association is only clearly demonstrated, however, in the two extreme levels of physical activity, which are no physical activity and strenuous physical activity. These levels of physical activity seem to show a progression of osteoarthritis of the knee in females regardless of the frequency. The different frequencies of physical activity did not seem to have a large impact on the effect of OA of the knee progression. However, the frequencies between one and four days per week appeared to demonstrate of a slight reversal in the progression of OA or a possible slowing of OA. The results found in this study suggest that women with OA of the knee should engage in light or moderate physical activity at a frequency of one to four days per week.

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